

09/744801  
JC07 Rec'd PCT/PTO 30 JAN 2001

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January 30, 2001

Assistant Commissioner  
of Patents  
Washington, D.C. 20231

**ATTN: BOX PCT**  
**PCT/AU98/00603**  
Attorney Docket: Q-62916

Re: Application of Rick Kiriakos LAZAROU for "CARBON BAKING FURNACE"

Sir:

Please enter the enclosed above identified application into the national stage commencement under Chapter II along with the claim to priority, executed Declaration, two (2) Small Entity Status Declarations, (two (2) sheets of drawings and Preliminary Amendment. It is assumed that copies of the Int'l Application, Int'l Search Report, International Preliminary Examination Report, and any Articles 19 and 34 amendments as required by §371(c) will be supplied directly by the Int'l Bureau, but if copies are needed, please notify the undersigned.

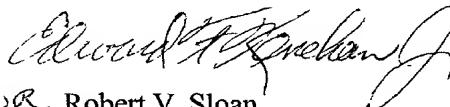
The Government filing fee is calculated as follows:

Total claims . . . . .  $\frac{25}{02} - 20 = \frac{05}{00} \times \$18/09 = \$ 45.00$   
Independent Claims .....  $\frac{02}{00} - 03 = \frac{00}{00} \times \$80/40 = \$$   
Basic Fee (1000/500) or (860/430) = \$ 430.00  
Multiple Dependent Claim Fee = \$  
Assignment Recordal Fee = \$  
**TOTAL FILING FEE** ..... \$ 475.00

Attached please find a check in the amount of \$ 475. for the basic filing fee and excess claim fee. You are directed and authorized to charge or credit any difference or overpayment to Deposit Account No. 19-4880.

Priority is claimed from International Application No. PCT/AU98/00603 was filed July 30, 1998. A duplicate copy of this transmittal letter is attached.

Respectfully submitted,

  
FOR Robert V. Sloan  
Reg. No. 22,775

REG NO  
28,962

RVS:jlg  
Attachments:

Applicant or Patentee: \_\_\_\_\_ Attorney's  
 Serial or Patent No.: \_\_\_\_\_ Docket No.: \_\_\_\_\_  
 Filed or Issued: \_\_\_\_\_  
 For: \_\_\_\_\_

VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY  
 STATUS (37 CFR 1.9 (f) and 1.27 (b)) — INDEPENDENT INVENTOR

As a below named inventor, I hereby declare that I qualify as an independent inventor as defined in 37 CFR 1.9 (c) for purposes of paying reduced fees under section 41 (a) and (b) of Title 35, United States Code, to the Patent and Trademark Office with regard to the invention entitled CARBON BAKING FURNACE described in

☒ [X] International Patent Application No PCT/AU98/00603 filed  
☐ [ ] the specification filed herewith  
☐ [ ] application serial no. \_\_\_\_\_, filed 30 July, 1998  
☐ [ ] patent no. \_\_\_\_\_, issued \_\_\_\_\_

I have not assigned, granted, conveyed or licensed and am under no obligation under contract or law to assign, grant, convey or license, any rights in the invention to any person who could not be classified as an independent inventor under 37 CFR 1.9 (c) if that person had made the invention, or to any concern which would not qualify as a small business concern under 37 CFR 1.9 (d) or a nonprofit organization under 37 CFR 1.9 (e).

Each person, concern or organization to which I have assigned, granted, conveyed, or licensed or am under an obligation under contract or law to assign, grant, convey, or license any rights in the invention is listed below:

- ☐ [ ] no such person, concern, or organization  
☒ [X] persons, concerns or organizations listed below\*

\*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities. (37 CFR 1.27)

FULL NAME LAZAR ENTERPRISES PTY LTD  
 ADDRESS 11a Kent Street, Hawthorn, Victoria 3122, Australia  
☐ [ ] INDIVIDUAL ☐ [ ] SMALL BUSINESS CONCERN ☐ [ ] NONPROFIT ORGANIZATION

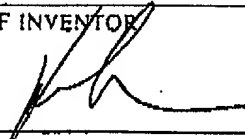
FULL NAME \_\_\_\_\_  
 ADDRESS \_\_\_\_\_  
☐ [ ] INDIVIDUAL ☐ [ ] SMALL BUSINESS CONCERN ☐ [ ] NONPROFIT ORGANIZATION

FULL NAME \_\_\_\_\_  
 ADDRESS \_\_\_\_\_  
☐ [ ] INDIVIDUAL ☐ [ ] SMALL BUSINESS CONCERN ☐ [ ] NONPROFIT ORGANIZATION

I acknowledge the duty to file, in this application or patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. (37 CFR 1.28 (b))

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

Rick Kiriakos LAZAROU

NAME OF INVENTOR	NAME OF INVENTOR	NAME OF INVENTOR
<u>X</u> 		
Signature of Inventor	Signature of Inventor	Signature of Inventor
<u>x 27/01/01</u>		
Date	Date	Date

Applicant or Patentee: \_\_\_\_\_ Attorney's Dkt. No. \_\_\_\_\_  
 Serial or Patent No.: \_\_\_\_\_  
 Filed or Issued: \_\_\_\_\_  
 For: \_\_\_\_\_

**VERIFIED STATEMENT (DECLARATION) CLAIMING SMALL ENTITY  
 STATUS [37 19(f) and 1.27(c)] - SMALL BUSINESS CONCERN**

I hereby declare that I am

- ☐ the owner of the small business concern identified below:  
☐ an official of the small business concern empowered to act on behalf of the concern identified below:

NAME OF CONCERN LAZAR ENTERPRISES PTY LTD

ADDRESS OF CONCERN 11a Kent Street, Hawthorn, Victoria 3122, Australia

I hereby declare that the above identified small business concern qualifies as a small business concern as defined in 13 CFR 121.3-18, and reproduced in 37 CFR 1.9(d), for purposes of paying reduced fees under section 41(a) and (b) of Title 35, United States Code, in that the number of employees of the concern, including those of its affiliates, does not exceed 500 persons. For purposes of this statement (1) the number of employees of the business concern is the average over the previous fiscal year of the concern of the persons employed on a full-time, part-time or temporary basis during each of the pay periods of the fiscal year, and (2) concerns are affiliates of each other when either, directly or indirectly, one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.

I hereby declare that rights under contract or law have been conveyed to and remain with the small business concern identified above with regard to the invention, entitled:

**CARBON BAKING FURNACE**

by inventors Rick Kiriaikos LAZAROU described in  
☐ the specification filed herewith International Patent Application No PCT/AU98/00603  
☐ application Serial No. \_\_\_\_\_, filed filed 30 July, 1998  
☐ patent No. \_\_\_\_\_, issued \_\_\_\_\_

If the rights held by the above-identified small business concern are not exclusive, each individual, concern or organization having rights to the invention is listed below and no rights to the invention are held by any person, other than the inventor who could not qualify as an independent inventor under 37 CFR 1.9(c) if that person made the invention, or by any concern which would not qualify as a small business concern under 37 CFR 1.9(d), or a nonprofit organization under 37 CFR 1.9(e). \*NOTE: Separate verified statements are required from each named person, concern or organization having rights to the invention averring to their status as small entities (37 CFR 1.27)

Name \_\_\_\_\_

Address \_\_\_\_\_

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

Name \_\_\_\_\_

Address \_\_\_\_\_

☐ Individual ☐ Small Business Concern ☐ Nonprofit Organization

I acknowledge the duty to file, in this application of patent, notification of any change in status resulting in loss of entitlement to small entity status prior to paying, or at the time of paying, the earliest of the issue fee or any maintenance fee due after the date on which status as a small entity is no longer appropriate. [37 CFR 1.28(b)]

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application, any patent issuing thereon, or any patent to which this verified statement is directed.

NAME OF PERSON SIGNING \* RICK KIRIAIKOS LAZAROU  
 TITLE OF PERSON OTHER THAN OWNER \*  
 ADDRESS OF PERSON SIGNING \* 11A KENT ST. HAWTHORN VIC 3121  
 SIGNATURE \* [Signature] DATE \* 29/01/01

09/744801

PATENT APPLICATION

JC07 Rec'd PCW/PTO 30 JAN 2001

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Rick Kiriakos LAZAROU

Filed: January 30, 2001

For: CARBON BAKING FURNACE

Ass't Commissioner of Patents  
Washington, D.C. 20231

ATT: APPLICATION BRANCH

Sir:

PRELIMINARY AMENDMENT

Prior to the examination of the above identified application,  
please amend this application as follows:

IN THE CLAIMS:

Claim 3, line 1, change "either claim 1 or claim 2" to --claim 1--.

Claim 4, line 1, change "any one of claims 1 to 3" to --claim 1--.

Claim 5, line 1, change "any one of claims 1 to 4" to --claim 1--.

Claim 6, line 1, change "any one of claims 1 to 5" to --claim 1--.

Claim 7, line 1, change "any of claims 1 to 6" to --claim 1 --.

Claim 8, line 1, change "any one of claims 4 to 7" to --claim 1--.

Claim 9, line 1, change "any one of claims 4 to 8" to --claim 4--.

Claim 10, line 1, change "any one of claims 1 to 9" to --claim 1--.

Claim 14, line 1, change "any one of claims 11 to 13" to --claim

11--.

## PATENT APPLICATION

Claim 15, line 1, change "any one of claims 11 to 14" to --claim  
11--.

Claim 16, line 1, change "any one of claims 11 to 15" to --claim  
11--.

Claim 18, line 1, change "any one of claims 11 to 17" to --claim  
11--.

Claim 19, line 1, change "any one of claims 11 to 18" to --claim  
11--.

Claim 20, line 1, change "any one of claims 11 to 19" to --claim  
11--.

Claim 21, line 1, change "any one of claims 11 to 20" to --claim  
11--.

Claim 22, line 1, change "any one of claims 11 to 21" to --claim  
11--.

Claim 23, line 1, change "any one of claims 11 to 22" to --claim  
11--.

Claim 24, line 1, change "any one of claims 11 to 23" to --claim  
11--.

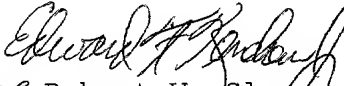
PATENT APPLICATION

REMARKS

The above claims have been amended to delete the multiple dependencies therein.

An early and favorable action on the merits is respectfully requested.

Respectfully submitted,

 REG NO  
28,962  
FOR Robert V. Sloan  
Reg. No. 22,775

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Att'y Docket No: Q-62916

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PCT/AU98/00603

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CARBON BAKING FURNACE

The present invention relates to the baking of carbon, in particular to the baking of carbon anodes such as for use in aluminium smelters. The present invention further relates to a  
5 carbon baking furnace, to a process for the baking of carbon articles and articles so baked.

The conversion of alumina to aluminium metal by electrolysis results in a substantial consumption of carbon anodes. Molten aluminium is deposited onto a carbon cathode and simultaneously oxygen is deposited on and consumes the carbon anode of the electrolytic cell.

10 Typically, up to 0.4 tonnes of carbon are consumed for every tonne of aluminium produced. As a result, aluminium smelters have a requirement for a substantial and continuous supply of carbon electrodes. It is common for smelters to manufacture carbon anodes on site as an integral part of the aluminium production process.

15 The manufacture of carbon anodes comprises producing "green" anode blocks and baking the "green" blocks to produce anodes suitable for use. The production of "green" blocks involves the mixing of crushed coke or anthracite with a binding agent which, for example, contains coal tar pitch. The viscous mixture is then pressed to form "green" anode blocks. Depending on the smelters' requirements, "green" anodes may typically weigh from a few hundred  
20 kilograms to more than a tonne. The mixture of coke and pitch binder is generally solid at room temperature and softens at temperatures over about 50°C. Volatile components are released at temperatures between 50°C and 400°C. When subjected to further heating over a period of time, to about 1200°C, the anode hardens, resulting in improved physical properties, such as electrical conductivity and resistance to oxidation.

25

Carbon anodes are typically manufactured in carbon baking furnaces which are often referred to as ring-type furnaces where "green" anode blocks are loaded into large pits, covered with sacrificial coke and baked. The furnace is generally a concrete tub lined with refractory materials to provide a number of pits into which a column of green anodes may be loaded for  
30 baking, usually about six deep. Each pit is typically surrounded by two flues for heating the

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anodes, the flue-walls also being lined with refractory materials. As each pit is loaded, "green" anodes are packed in with sacrificial coke. These furnaces typically require baking cycles of about 2 to 3 weeks which includes preheating and the time that the baked anode is left in the pit to cool prior to removal.

5

The thermal cycling of these types of carbon baking furnaces causes adverse effects on the refractory materials, concrete and other ceramic components. The refractory materials deform with heat and time, resulting in altered brick dimensions. Further, packing coke material may lodge into expansion gaps which, together with temperature cycling, leads to large structural deformation of walls and ultimately failure.

Deformed flue walls must be regularly replaced as excessive tub-wall deformation results in an inefficient operation and necessitates furnace rebuilding. Costs associated with regular flue-wall replacement and maintenance of joints and tub-walls can be as high as 50% of the overall anode baking costs.

We have now found a furnace configuration which overcomes or at least substantially alleviates the problems associated with the conventional ring-type furnaces.

According to the present invention there is now provided a carbon baking furnace comprising a refractory lined kiln defining a baking path, further comprising a means for substantially continuously receiving green carbon articles, means for packing said green carbon articles in a sacrificial medium, a means for substantially continuously displacing of the packed carbon articles through said baking path and a means for substantially continuously removing baked carbon articles from the kiln.

In a second aspect there is provided a process for baking carbon articles, said process comprising the steps of substantially continuously loading green carbon articles into a refractory lined kiln, said kiln defining a baking path, packing said green carbon articles in a sacrificial medium, substantially continuously displacing the carbon articles through said



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baking path and substantially continuously removing baked carbon articles from the kiln.

Advantageously, the present invention provides carbon articles which have been subjected to more consistent temperature treatments. This results in articles of improved baked quality.

5 In the manufacture of baked carbon anodes for use in aluminium smelting operations, improved baked quality contributes significantly to cell efficiency. Temperature gradients in excess of 150°C in a single pit of ring type furnaces are not uncommon. Such high temperature gradients may result in thermo-mechanical degradation of the anode matrix. The present invention may reduce or eliminate cracking of the anodes which may otherwise result

10 from excessive temperature gradients in the baking process.

It will be understood that the term "substantially continuously" refers to a continuous mode of operation whereby carbon articles are passed continuously through the kiln. The carbon articles are passed through the kiln at either a uniform rate or may involve a periodic or step-

15 wise passage through the kiln. This will be determined primarily by the means for receiving and removing the articles from the kiln.

The refractory lined kiln may be any convenient refractory lined kiln which incorporates a baking path through which the carbon articles may pass and which is capable of heating the

20 carbon articles up to the desired baking temperatures, typically about 1200°C to 1300°C.

Preferably the refractory lined kiln may comprise a number of heating zones whereby each heating zone is capable of maintaining the carbon articles at a desired temperature. The refractory lined kiln of the present invention may be operated continuously thereby permitting

25 each heating zone to be operated at an equilibrium temperature with little or no thermal cycling. The operation at equilibrium temperatures permits greater fuel efficiency as fuel which would otherwise be spent in the reheating of furnace components in ring-type furnaces may be eliminated. In the present invention fuel need only be used to provide the necessary calorific values required to bake the anodes (not heating and reheating refractory

30 substructures).

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Furthermore, the operation of the refractory lined kiln under equilibrium conditions allows structural materials such as refractories, concrete supports and other ceramic products to be maintained at relatively constant temperatures over an extended period, substantially reducing thermal cycling of these materials. The furnace may then be able to operate for longer  
5 periods without extensive maintenance or rebuilding. Furnace rebuilds costing tens of millions of dollars are standard in ring-type furnaces. Such rebuilds may take place at approximately five- yearly intervals. Thermal cycling of refractories will be substantially reduced according to the present invention and concomitantly the useful life of the furnace will be greatly extended.

10

Refractories may also advantageously be selected according to the heating zone in the kiln in which they are intended for use thereby permitting the efficiency and operating life of the furnace to be optimised. For example, in a preheat/volatiles extraction zone, low permeability refractories with high resistance to volatiles attack, such as those refractories  
15 used in incinerators are preferred. In the high temperature zone, refractories with high resistance to thermomechanical degradation are preferred. Alumina silicates, such as those having greater than 45% alumina may be used in these and other zones of the kiln.

The refractories may include guides, such as protrusions, to position the carbon articles within  
20 the baking path defined by the refractory lined kiln. It is desirable that the baking path be substantially linear so as to permit the carbon articles to be readily conveyed along the baking path with a minimum requirement for actuators or conveyors to operate or be located within the kiln. Preferably, the sacrificial medium is sufficient to support and guide the carbon articles without the need for actuators to be located in the high temperature regions of the  
25 kiln.

Preferably the kiln may comprise a number of heating zones in order to provide optimum control of temperature treatment of the carbon articles. Defined thermal gradients along the carbon baking furnace make it possible to separate heating and volatile extraction zones. It  
30 is preferable that the kiln comprise a first heating zone whereby the carbon article is heated

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to a temperature whereby any volatile materials are removed from the furnace to reduce chemical degradation of the refractories and/or other kiln components and to reduce the possibility of explosion within the kiln. The extraction of volatile organic compounds from the kiln permits these potentially toxic compounds to be contained. Optionally these volatile  
5 organic compounds may be extracted and pumped into the heating zone with the fuel and combusted as part of the heating of the kiln. This minimises the likelihood of any emissions of volatile materials such as pitch fumes from the furnace into the environment.

Furthermore, the containment of pitch fumes is particularly desirable as pitch condensates are  
10 extremely difficult to handle and costly to eliminate. Current technologies, due to design limitations, are unable to fully combust or efficiently contain these toxins. Pitch fumes escape from the furnace environment or condense within the ringmains. Pitch condensates are extremely difficult to handle and are costly to eliminate. The present invention makes it possible to reduce the risk of exposing workers to these highly toxic substances.

15 Second and subsequent heating zones may be used to control the rate of increase of the temperature of the carbon articles as they substantially continuously pass through the baking path. The rate at which the carbon articles pass through the baking path and the configuration of the heating zones in the kiln will determine the temperature gradient across the carbon  
20 articles and the heat treatment profile to which the carbon articles are subjected.

Preferably, the kiln defines a vertical baking path whereby the carbon articles are displaced downwardly through the baking path as a result of the weight of the carbon article and the weight of the sacrificial medium and subsequent carbon articles stacked above. The rate at  
25 which the carbon articles pass through the baking path may conveniently be regulated by substantially continuously removing the bottom most baked carbon article from the kiln in a manner whereby the weight of the carbon articles and the sacrificial medium is supported within the kiln and the remaining carbon articles are substantially continuously displaced through the baking path.

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Alternatively the kiln may define a substantially horizontal baking path or a baking path on an inclined plane whereby the carbon articles are substantially continuously displaced through the baking path by a push rod or other convenient means.

- 5 The means for substantially continuously receiving green carbon articles may be any convenient means, dependent on the configuration and orientation of the refractory lined kiln and the baking path. We have found that the use of a conveyor and a hydraulic ram is particularly suited to a kiln having a vertical baking path wherein the green carbon articles are received at the top of the kiln. The conveyor may position the green carbon article  
10 adjacent to the top of the kiln and the hydraulic ram place the green carbon article into the top of the baking path.

- The means for packing the green carbon articles in a sacrificial medium may be any convenient means dependent on the morphology of the sacrificial medium. Preferably the  
15 sacrificial medium is a friable packing coke. The means for packing the green carbon articles in a friable sacrificial medium may include a hopper fitted with a suitable nozzle whereby the sacrificial medium is spread over and around the green carbon article. Preferably the sacrificial medium occupies the remaining space in the kiln once the carbon articles have been located therein. It is desirable to reduce the amount of free space in the kiln.

20

- Refractory spacers are preferably used to separate the carbon articles in the kiln so as to prevent the carbon articles being baked together and to alleviate difficulties in separating the baked carbon articles when they are removed from the baking path. Suitable spacers may be made from consumable materials such as aluminium sheets, cardboard, or paper.  
25 Alternatively the spacers may be made from refractory or carbonaceous materials, such spacers may be reused or recycled.

- The means for the substantially continuous displacement of the carbon articles through the baking path may include means whereby the carbon articles are forced or pushed through the  
30 baking path. Preferably gravity, or the weight of the column of carbon articles in a vertical

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baking path is used to urge the carbon articles through the baking path and the substantially continued displacement of the carbon articles is achieved by retarding or braking the movement of the lower or lowest carbon articles thereby exercising control over the rate at which the carbon articles pass down the kiln.

5

The means for substantially continuously removing the baked carbon article from the kiln may be any convenient means depending on the configuration and orientation of the kiln. In the preferred configuration and orientation of the kiln where the baking path is substantially vertical and the carbon articles pass down the kiln under their own weight and the weight of  
10 the sacrificial medium, a preferred means for substantially continuously removing the baked carbon articles from the kiln includes the use of hydraulic rams and conveyor belts. The bottom-most baked carbon article is preferably supported such as by a hydraulic ram while the adjacent baked carbon article is engaged by a second pair of opposed rams so as to restrain or support all but the bottom-most baked carbon article. The bottom-most baked  
15 carbon article is then lowered or positioned by the first mentioned hydraulic ram onto a conveyor belt for storage and/or use.

The sacrificial medium may be any medium which will protect the carbon articles during the baking process. The sacrificial medium may preferentially react with or absorb the oxygen  
20 in the kiln prior to its reaction with the carbon in the articles being baked. It is preferred that the sacrificial medium be friable to permit it easy incorporation around the carbon articles and to permit the easy movement of the carbon articles within the kiln. The sacrificial medium may be selected so as to provide an optimum balance of rendering the carbon articles easily moveable through the furnace and providing sufficient protection of the carbon articles from  
25 oxygen contained within the kiln. Preferably the sacrificial medium is packing coke having a maximum particle size of less than 15mm.

It is also desirable for the sacrificial medium to conduct heat efficiently to the carbon articles. For this reason, it is desirable that the amount of sacrificial medium used is sufficient to  
30 provide adequate protection for the carbon articles from oxygen, permit the easy movement

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of the carbon articles in the kiln and to provide efficient heat transfer.

Desirably the sacrificial medium may be collected from the furnace and, so far as is capable, be recycled for packing further green carbon articles. For example, the flow of this medium  
5 may be controlled by the use of a pendulous carbon trough, the flow rate being proportional to the period of oscillation.

The furnaces of the present invention may be arranged such that a plurality of such furnaces are positioned adjacent to one another so as to permit the efficient use of equipment and  
10 heating values in the fuel.

We have found that improved control of temperature permits more even heat treatment of the carbon articles and the manufacture of carbon articles having higher baked quality. Additionally, anode deformation, otherwise known as "slumping", during baking which a  
15 problem in ring furnaces is insignificant. Green anodes subjected to loads at varying temperatures reveal dimensional instability in the 25°C to 150°C temperature range. This is directly related to the temperature zone at which anode volatiles are emitted. We have found that anodes (regardless of load) maintain their structural integrity at temperatures beyond 150°C and the degree of permanent deformation is less than 0.5%

20

Current carbon baking furnace designs operate within narrow parameters, the distance between the anodes and flue walls is critical to achieving optimum baking. In the past this inflexibility in design has presented operators with costly refurbishment when anode design changes are required. The carbon baking furnace of the present invention may more easily  
25 be modified to accommodate anode design changes and to control carbon anode temperature, such as by varying the rate at which they are passed through the various temperature zones and the temperature of said zones. Furthermore, baking temperatures may be optimised to improve in anode baking.

30 The carbon baking furnace of the present invention is able to accommodate anodes of varying

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size with minimal structural change. Temperature profiles can be tailored by altering configuration of the columns heat exchange systems.

Advantageously, the carbon baking furnace of the present invention may result in a significant  
5 reduction in fuel consumption, more uniform baking of anodes and efficient toxic volatiles  
elimination. The substantially continuous flow of anodes and coke through the carbon baking  
furnace eliminates the need for expensive and labour intensive loading and unloading  
procedures as in existing furnace designs. Large multipurpose cranes costing more than 10%  
of the overall capital budget of ring type furnaces requiring high ongoing operating costs may  
10 be eliminated. The present invention permits a fully automated anode and packing coke  
loading and unloading system, along with the resultant increased productivity.

In general, the continuous furnace of the present invention will require approximately one  
fifth of the surface area needed to accommodate an equivalent ring-type furnace. The  
15 continuous furnace of the present invention may typically be between 20m and 30m high,  
with anode velocities between 3 and 4.5m/day.

Throughout this specification and the claims which follow, unless the context requires  
otherwise, the word "comprise", or variations such as "comprises" or "comprising", will be  
20 understood to imply the inclusion of a stated integer or group of integers but not the exclusion  
of any other integer or group of integers.

The present invention will now be further described with reference to the accompanying  
drawings. In the drawings the carbon articles are represented by anodes for use in the  
25 aluminium smelting industry. It will be understood that the present invention applies equally  
to the baking of other carbon articles.

Figure 1 is a cross sectional view of the carbon baking furnace of the present invention.

Figure 2 is a cutaway perspective diagram of a preferred embodiment of the carbon baking  
30 furnace of the present invention.

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The carbon baking furnace(1) shown in Figure 1 incorporates a refractory lined kiln(2) and a heating means(4). Green carbon anodes(3) are encased in packing coke(6) and are substantially continuously fed through the heating zone generated by the heating means(4). Baked carbon anodes(5) are produced after passing through the heating zone. Means for receiving green carbon anodes (not shown) and means for removing baked carbon anodes (not shown) assist to control the rate at which the anodes pass through the heating zone and the temperature profile to which they are subjected.

Figure 2 shows a preferred configuration of the carbon baking furnace of the present invention. Figure 2 is a cutaway perspective drawing. Green carbon anodes(3) are positioned adjacent the refractory lined kiln(2) by conveyor belt(7). Hydraulic rams(8) position the green carbon anodes (3) over the baking path of refractory lined kiln(2). The bottom-most baked carbon anode(5) is lowered by hydraulic ram(9) after the adjacent carbon anode(10) is engaged by hydraulic rams(11). Baked carbon anode (5) is then positioned by hydraulic ram(9) on conveyor belt(12) for storage and/or use. Hydraulic ram(9) engages baked carbon anode(10), hydraulic rams (11) disengage baked carbon anode(10) and hydraulic ram(9) lowers baked carbon anode(10) into the position previously occupied by baked carbon anode(5) as a result the column of anodes moves downwards in a substantially continuous manner.

20

Green carbon anode(3) is positioned on a spacing element(13). Packing coke(6) is then fed by hopper(14) through nozzle(15) to fill the space surrounding the green carbon anode(3) in the kiln(2). As the carbon anodes pass through the kiln(2) the carbon anodes enter a volatile extraction zone(16). Volatiles such as pitch fumes are extracted through holes in the refractory materials(17) through extraction unit(18). The extracted fumes are fed into the heating unit(19) in addition to fuel in order to provide sufficient calorific values to raise the temperature of the carbon anodes to the desired baking temperature. The fuel is fed into the heating unit(19) through nozzle(20).

30 After the anodes have passed through the high temperature zone adjacent to the heating



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unit(19) the packing coke(6) is removed from the baked anodes by scrapers(21). The packing coke(6) which has been removed from the baked carbon anodes is then transported on conveyor belts(23) and (24) and returned to the hoppers(14) via continuous buckets(25) and conveyor belt(26).

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Those skilled in the art will appreciate that the invention described herein is susceptible to variations and modifications other than those specifically described. It is to be understood that the invention includes all such variations and modifications which fall within its spirit and scope. The invention also includes all of the steps, features, compositions and compounds 10 referred to or indicated in this specification, individually or collectively, and any and all combinations of any two or more of said steps or features.

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**CLAIMS**

1. A carbon baking furnace comprising a refractory lined kiln defining a baking path,  
further comprising a means for substantially continuously receiving green carbon articles,  
5 means for packing said green carbon articles in a sacrificial medium, a means for substantially  
continuously displacement of the packed carbon articles through said baking path and a means  
for substantially continuously removing baked carbon articles from the kiln.
2. A carbon baking furnace according to claim 1 wherein said refractory lined kiln  
10 comprises a plurality of heating zones.
3. A carbon baking furnace according to either claim 1 or claim 2 wherein said refractory  
lined kiln comprises a first heating zone capable of heating the green carbon article to remove  
volatile organic compounds and second and subsequent heating zones for baking the carbon  
15 articles.
4. A carbon baking furnace according to any one of claims 1 to 3 wherein said baking  
path is substantially linear.
- 20 5. A carbon baking furnace according to any one of claims 1 to 4 wherein said baking  
path is substantially vertical.
6. A carbon baking furnace according to any one of claims 1 to 5 wherein said sacrificial  
medium is packing coke having a particle size having a maximum particle size of less than  
25 15mm.
7. A carbon baking furnace according to any one of claims 1 to 6 wherein the refractory  
lined kiln comprises guides to position the carbon articles within the baking path.
- 30 8. A carbon baking furnace according to any one of claims 4 to 7 wherein the means for

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substantially continuously receiving green carbon articles comprises a conveyor and a hydraulic ram whereby the conveyor positions the green carbon article adjacent to the top of the vertical baking path and the hydraulic ram positions the green carbon article into the top of the baking path.

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9 . A carbon baking furnace according to any one of claims 4 to 8 wherein the means for substantially continuously removing green carbon articles from a substantially vertical baking path comprises a plurality of hydraulic rams and conveyor belt wherein the bottom-most baked carbon article is supported by a hydraulic ram while the adjacent baked carbon article  
10 is engaged and supported by a second pair of opposed rams and wherein the bottom-most baked carbon article is subsequently positioned by the first mentioned hydraulic ram onto a conveyor belt.

10 . A carbon baking furnace according to any one of claims 1 to 9 wherein the means for  
15 packing the green carbon articles in a sacrificial medium comprises a hopper fitted with a nozzle whereby the sacrificial medium is spread over and around the green carbon article.

11 . A process for baking carbon articles, said process comprising the steps of substantially continuously loading green carbon articles into a refractory lined kiln, said kiln defining a  
20 baking path, packing said green carbon articles in a sacrificial medium, substantially continuously displacing the carbon articles through said baking path and substantially continuously removing baked carbon articles from the kiln.

12 . A process for baking carbon articles according to claim 11 wherein the carbon articles  
25 are passed through the kiln at a uniform rate.

13 . A process for baking carbon articles according to claim 11 wherein the carbon articles are passed through the kiln at a step-wise rate..

30 14 . A process for baking carbon articles according to any one of claims 11 to 13 wherein

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refractory lined kiln operates at equilibrium temperatures.

15 . A process for baking carbon articles according to any one of claims 11 to 14 wherein said baking path is substantially linear.

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16 . A process for baking carbon articles according to any one of claims 11 to 15 wherein said baking path is substantially vertical.

17 . A process for baking carbon articles according claims 16 wherein the substantially  
10 continued displacement of the carbon articles is achieved by retarding or braking the movement of the lower or lowest carbon articles thereby exercising control over the rate at which the carbon articles pass down the substantially vertical baking path.

18 . A process for baking carbon articles according to any one of claims 11 to 17 wherein  
15 the volatile organic compounds are extracted from the kiln.

19 . A process for baking carbon articles according to any one of claims 11 to 18 wherein said sacrificial medium is packing coke having a particle size having a maximum particle size of less than 15mm.

20.

20 . A process for baking carbon articles according to any one of claims 11 to 19 wherein the refractory lined kiln comprises guides to position the carbon articles within the baking path.

25 21 . A process for baking carbon articles according to any one of claims 11 to 20 wherein the means for substantially continuously receiving green carbon articles comprises a conveyor and a hydraulic ram whereby the conveyor positions the green carbon article adjacent to the top of the vertical baking path and the hydraulic ram positions the green carbon article into the top of the baking path.

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22. A process for baking carbon articles according to any one of claims 11 to 21 wherein the means for substantially continuously removing green carbon articles from a substantially vertical baking path comprises a plurality of hydraulic rams and conveyor belt wherein the bottom-most baked carbon article is supported by a hydraulic ram while the adjacent baked carbon article is engaged and supported by a second pair of opposed rams and wherein the bottom-most baked carbon article is subsequently positioned by the first mentioned hydraulic ram onto a conveyor belt.

23. A process according to any one of claims 11 to 22 wherein the means for packing the  
10 green carbon articles in a sacrificial medium comprises a hopper fitted with a nozzle whereby  
the sacrificial medium is spread over and around the green carbon article.

24. A baked carbon article produced by a process according to any one of claims 11 to 23.

15 25. A baked carbon article according to claim 24 wherein said article is a carbon anode.

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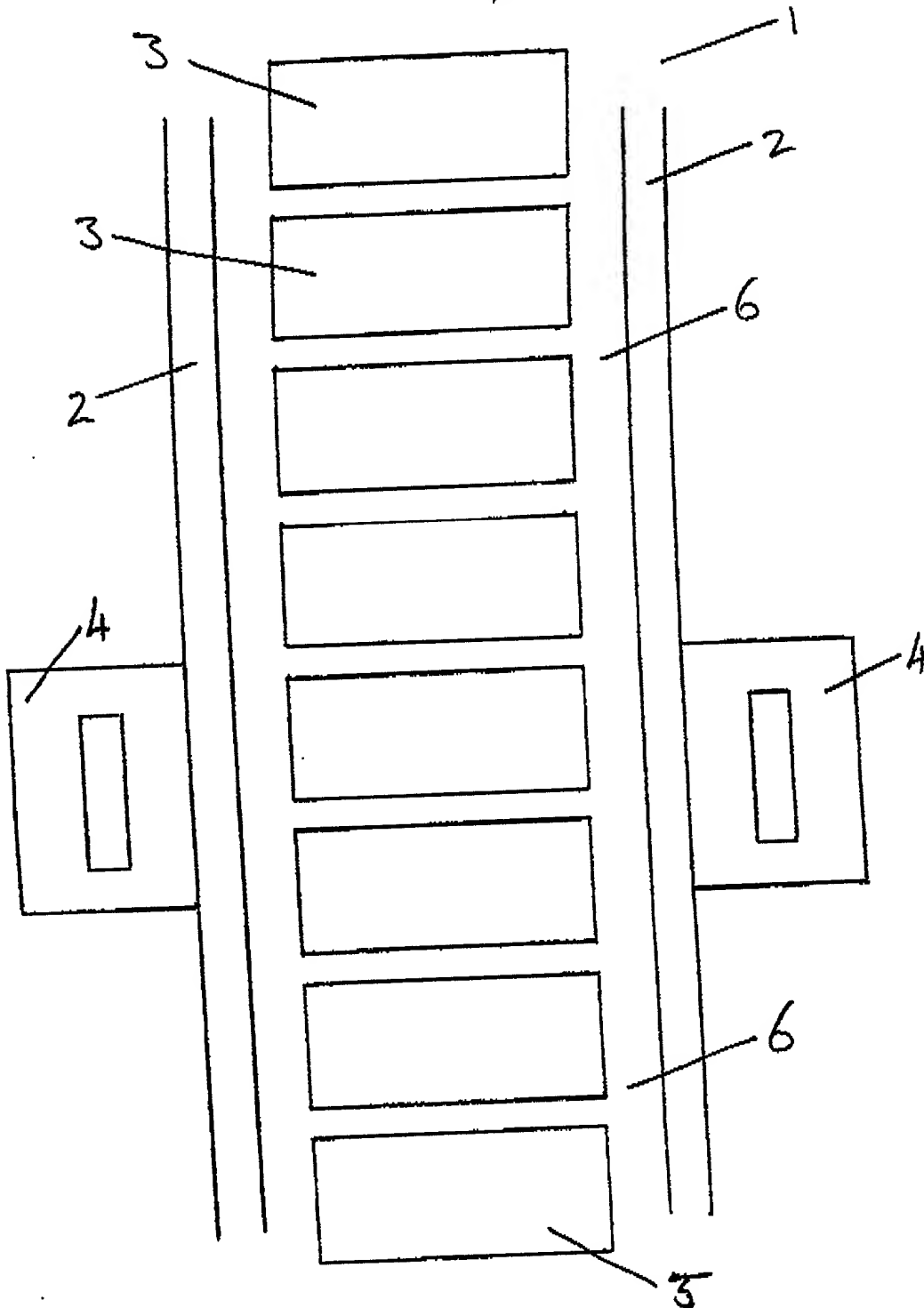


FIGURE 1

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FIGURE 2

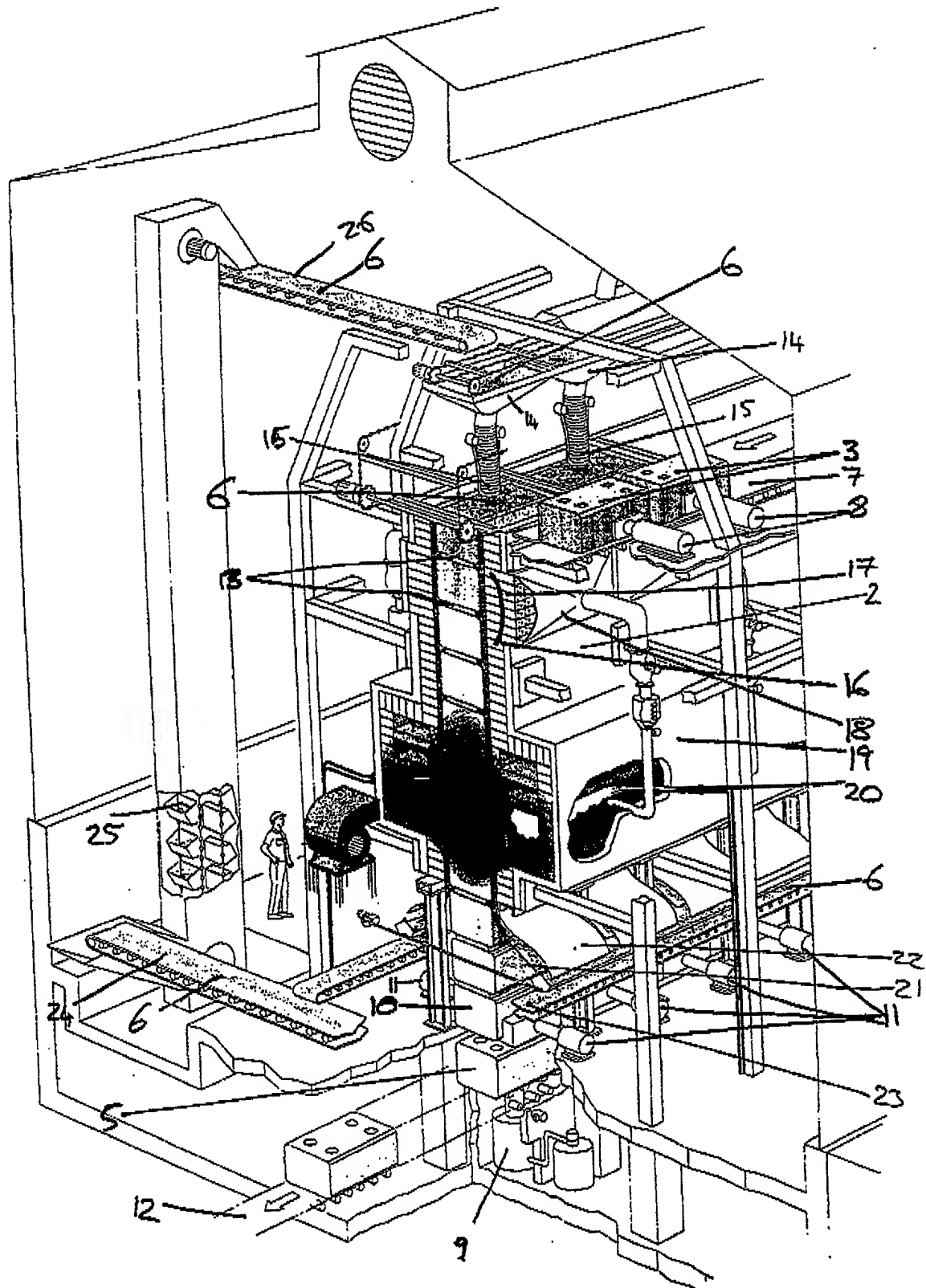


FIGURE 2

## SOLE/JOINT

## DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name: that I verily believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter claimed and for which a patent is sought in the application entitled: **CARBON BAKING FURNACE**

[x] International Patent Application No PCT/AU98/00603 filed 30 July, 1998

which application is:

☒ the attached application  
(for original application)

☐ application Serial No. \_\_\_\_\_  
filed \_\_\_\_\_, and amended on \_\_\_\_\_

(for declaration not accompanying application)

that I have reviewed and understand the contents of the specification of the above-identified application, including the claims, as amended by any amendment referred to above; that I acknowledge my duty to disclose information of which I am aware which is material to the patentability of this application under 37 C.F.R. 1.56, that I hereby claim priority benefits under Title 35, United States Code §119, §172 or §365 of any provisional application or foreign application(s) for patent or inventor's certificate listed below and have also identified on said list any foreign application for patent or inventor's certificate on this invention having a filing date before that of any foreign application on which priority is claimed:

Application Number	Country	Filing Date	Priority Claimed (yes or no)
PO 8369	Australia	1 August, 1997	yes NO <i>pk</i>

I hereby claim the benefit of Title 35, United States Code §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in a listed prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge my duty to disclose any information material to the patentability of this application under 37 C.F.R. 1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application:

Application Serial No.	Filing Date	Status (patented, pending, abandoned)

I hereby appoint John H. Mion, Reg. No. 18,879; Thomas J. Macpeak, Reg. No. 19,292; Robert J. Seas, Jr., Reg. No. 21,092; Darryl Mexic, Reg. No. 23,063; Robert V. Sloan, Reg. No. 22,775; Peter D. Olexy, Reg. No. 24,513; J. Frank Osha, Reg. No. 24,625; Waddell A. Biggart, Reg. No. 24,861; Louis Gubinsky, Reg. No. 24,835; Neil B. Siegel, Reg. No. 25,200; David J. Cushing, Reg. No. 28,703; John R. Inge, Reg. No. 26,916; Joseph J. Ruch, Jr., Reg. No. 26,577; Sheldon I. Landsman, Reg. No. 25,430; Richard C. Turner, Reg. No. 29,710; Howard L. Bernstein, Reg. No. 25,665; Alan J. Kasper, Reg. No. 25,426; Kenneth J. Burchfiel, Reg. No. 31,333; Gordon Kit, Reg. No. 30,764; Susan J. Mack, Reg. No. 30,951; Frank L. Bernstein, Reg. No. 31,484; Mark Boland, Reg. No. 32,197; William H. Mandir, Reg. No. 32,156; Brian W. Hannon, Reg. No. 32,778; Abraham J. Rosner, Reg. No. 33,276; Bruce E. Kramer, Reg. No. 33,725; Paul F. Neils, Reg. No. 33,102; Brett S. Sylvester, Reg. No. 32,765; Robert M. Masters, Reg. No. 35,603 and George F. Lehnigk, Reg. No. 36,359 my attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith, and request that all correspondence about the application be addressed to SUGHRUE, MION, ZINN, MACPEAK & SEAS, PLLC, 2100 Pennsylvania Avenue, N.W., Washington, D.C. 20037-3202.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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